31.

On the Life History and Development of the Sponge Blenny, *Paraclinus marmoratus* (Steindachner).

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(Plates I-IV; Text-figures 1-3).

Introduction.

This study of the life history and development of the sponge blenny, *Paraclinus marmoratus* (Steindachner), was carried on during February, 1939, as time would allow, while researches on the life history and habits of the tarpon were being undertaken at the research station of the New York Aquarium located at Palmetto Key on the west coast of Florida. This is west of Useppa Island, in Charlotte Harbor. See Breder (1939) for a description of the area. The bulk of the collecting was done by Mr. M. B. Bishop of the Peabody Museum, Yale University. Were it not for his persistence, it would have been impossible to examine so much material, both of adults and egg clusters. His vigorous field activity released the author for the necessary laboratory study of the living material. Also his subsequent collections up to June have given us an understanding of the post-breeding activity of these fishes and some idea of the rate of growth of the young. Dr. W. G. Van Name kindly identified the sponge through the good services of Dr. R. W. Miner. Mr. J. Atz of the New York Aquarium was helpful with the manuscript. The photographs, Plate II, Figure 3, Plate III and Plate IV were made by Mr. S. C. Dunton of the Aquarium.

The Mature Fish.

The taxonomy of this group of blennies (usually called *Auchenopterus* or *Cremnobates*) has long been confused. However, Margaret Storey (1940, in press) shows that the generic name *Paraclinus* must be used. The material with which we worked, incident to the present field studies, is the same that passed through her hands.

The physical appearance of these fishes, both male and female, is shown in Plate I, Figure 1. The adults ran between 60 and 80 mm. in standard length. The higher and differently appearing anterior dorsal spines and head form of the male is evident. There was no difficulty in sexing the living specimens, even in the case of recently spawned-out females, because of these evident and presumably permanent differences.

The life colors and patterns are rather difficult to describe briefly. The same Plate shows the pattern of the anterior part well enough, but its wide range of color and the shifts in detail which it underwent on slight provocation would take pages of descriptive detail. In the main the shades ran from light tan to Vandyke brown to almost black in some cases, or from light tan to pale green and almost yellowish. Specimens sent to the New York Aquarium and placed against backgrounds of unaccustomed sorts exceed these general types found in the field. Some became almost brick red while others became so light as to appear almost white. This latter was clearly not a matter of failing health.

When newly placed in a collecting bucket or an aquarium and frightened, they would seem to huddle together, but as soon as they obtained their bearings their attitude would become that of the typical solitary or cryptic fish in that they strongly resented each other. Generally, if a fish was huddled into the angle formed by the bottom and side of an aquarium, which was perhaps its most usual choice, it would remain quiescent when a wandering specimen sidled up to it *if* he approached quietly from the rear. If, on the other hand, he happened to be coming the other way—that is, head on—the quiescent fish would become alert and take a stance not unlike that shown in Plate II, Figure 3. This would be accompanied by a great extension of the wide opening gape and a spreading of the large pectorals by both fishes, with what appeared to be intimidating gestures and motions. No damage was seen to be done, the intruder usually withdrawing after a sudden lurch forward with a vicious snap by the other fish. Apparently such is not always the result, for torn fins were sometimes seen which would seem surely to be the results of such encounters carried a little further.

As may be seen in the various illustrations, these fishes have a very great thigmotaxis and spend almost their entire time in crevices or cavities, apparently leaving them only when forced to do so by some untoward circumstance. They are not strong swimmers, their movements all being made by little jerks. Since they are very heavy in relation to sea water, they are as much a part of the bottom fauna as a heavy-bodied crab. Their ventral fins they use as props, sitting up tripod fashion on the tail and their pelvic apendages. The pectorals are wide and with heavy rays and have remarkable utility for wedging into crevices that are basically too large for the fish's body to fit into neatly. A peculiar trick of this species is to walk along the bottom on their delicate ventral fins, alternating them like little legs.

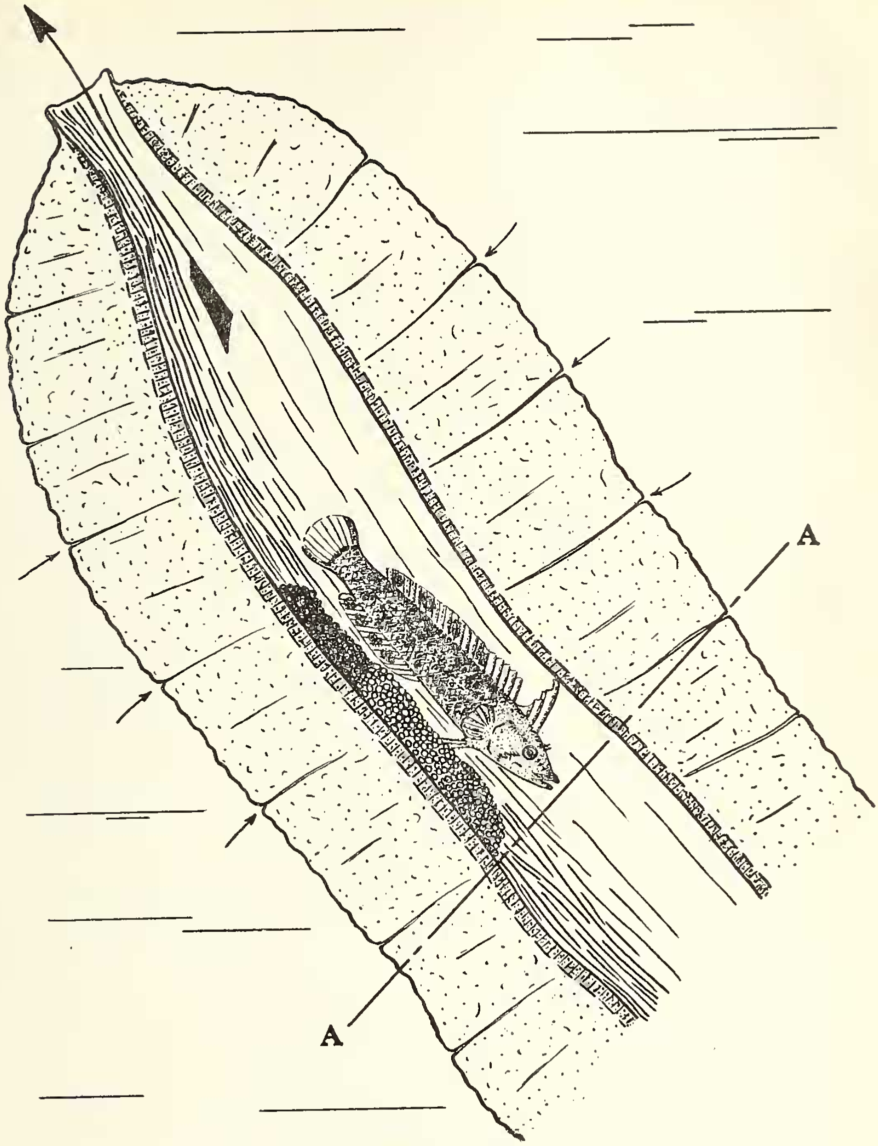
After a short sojourn in an aquarium, they fed freely on all manner of small organisms such as isopods, copepods, bits of fish, and so on. The large mouth enabled them to engulf surprisingly large objects and very likely they managed to catch a wide variety of invertebrates and smaller fishes without moving far from their normal lurking places.

The Habitat.

All the material on which the present study is based was collected in Pelican Bay, a small body of water about one-half mile north of Palmetto Key. The collection area could be waded easily at low water, and both adults and eggs were taken by gathering up the very abundant yellow sponge, *Verongia fistularis* (Pallas). During the time of these collections, February, every fourth or fifth sponge would be found to contain one or more fish and a much lesser number to contain eggs, usually with an attendant parent.

Associated with them in the sponge cavities were *Opsanus beta* Goode & Bean, and *Bathygobius soporator* (Cuvier & Valenciennes). Other fishes did not seem to find these same refuges, but they were shared with a large number of invertebrates, including small octopi, various shrimps and prawns, small starfish, brittle stars and a large variety of other crustaceans and mollusks.

No very brisk tidal flow was noted but there was a good change of water, nevertheless, due no doubt to the open nature of the so-called bay, which was only enclosed by a scattering of the islands common to this region. This area was in clean,open water, well away from any mangrove stands and the associated turbidity frequently found in such places.



Text-figure 1.

Diagram of nest within the lumen of a sponge, in saggital section. Line A-A indicates region of transverse section shown in Plate III, Figure 5. The three clutches of eggs are indicated by progressive darkening. The arrows indicate direction of flow induced by the sponge. The exact position of the fish is hypothetical, based on observation in aquaria.

The Nest.

The nesting cavities selected by the fish were found to be exceedingly varied. Most frequently they were found in broken-open lumens of old sponges that had partly healed over. Such an instance is depicted in Plate

III, Figure 6. Only one was found in the central lumen of a vertical sponge. Whether deliberate or accidental, this nest certainly had the benefit of the flow induced by this sponge. It is to be noted in this connection that the flow from the oscula of these sponges is remarkably strong, so much so that the amount of water that passes through in an hour must run into many gallons. A diagram of this particular nesting site is given in Text-figure 1, and a photograph of it in cross section in Plate III, Figure 5. Portions of other sponges dissected away are given in Plate I, Figure 2; Plate III, Figures 5 and 6; Plate IV, Figures 7 and 8.

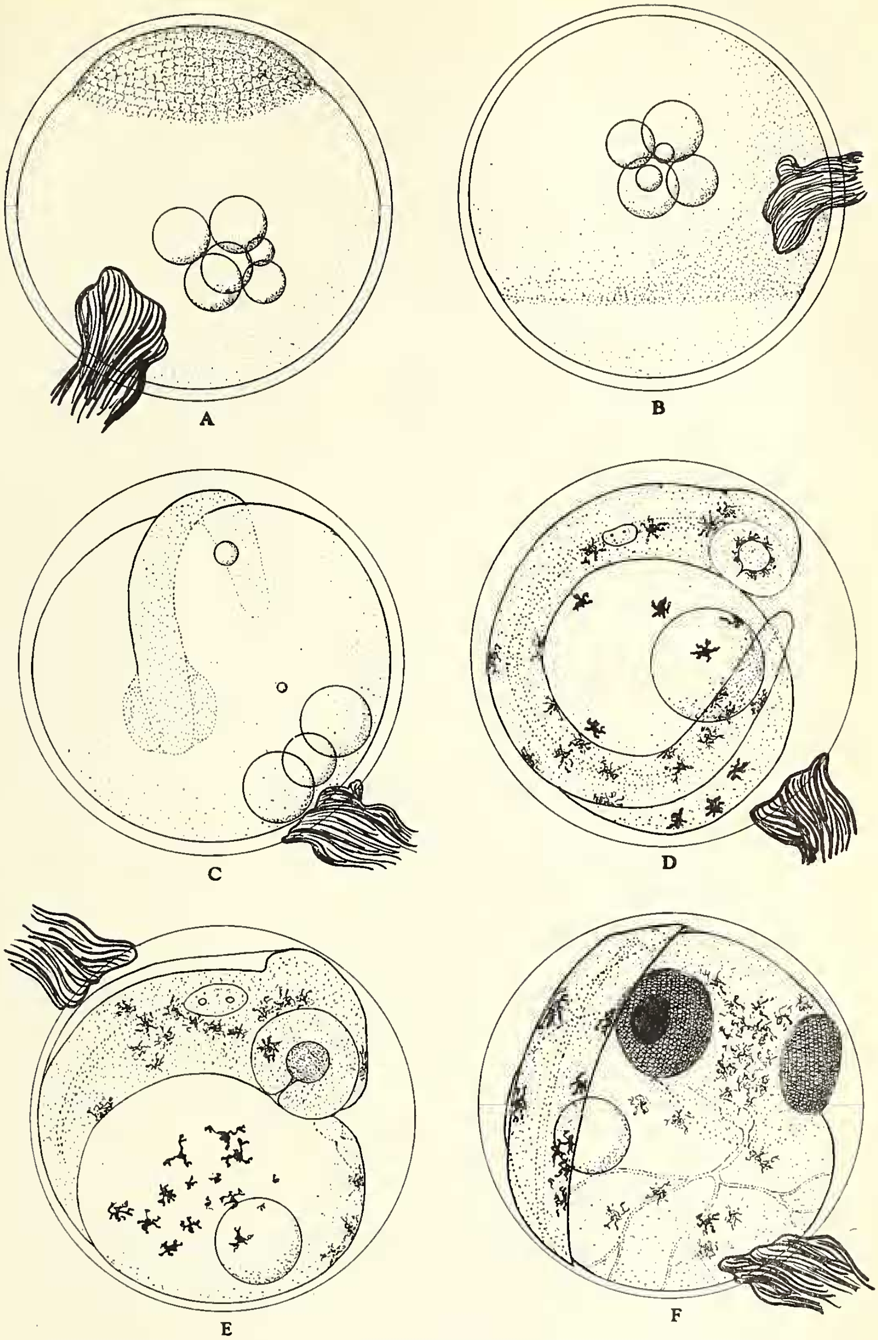
In many cases a fish was taken in company with the nests—a male in each instance. This indicates that this sex, as so common with fishes, at least guarded and probably fanned the eggs in their tightly compressed mass. Presumably in those cases in which there was no accompanying male, the fish slipped from the cavity as the sponge was removed from the water. This is further substantiated by aquarium observation. One male sent to the New York Aquarium established itself in a fork of a sea fan in one of the exhibition aquaria. It induced one female to spawn there. Since this activity was not observed, it is believed that spawning took place at night. The male was subsequently noted to fan the eggs, during which operation it exhibited a peculiar rocking motion. On the approach of an intruder it would open its mouth wide in a "threatening" attitude and spread its pectoral fins widely. Nevertheless, the eggs were found missing one morning, presumably successfully raided by some tank mate. Plate II, Figure 3, shows this male in a threatening attitude. When alarmed, this fish will erect the first dorsal spine so that it passes the vertical and actually leans forward. The male to the left in Plate 1, Figure 2, shows this posture.

Although actual spawning has not been observed, there are certain evidences from the eggs which indicated that once a male establishes himself he is ready to spawn with a succession of females. More frequently than not, the nests contained eggs in various stages of development, as well, in some instances, as hatched egg shells. Each batch of a single stage was found in one part of the generally agglutinated mass and represented a bulk about equal to the ovarian contents of a single female. Usually the stages of development to the number of four or five were in a linear series, forming in all an elongate mass flattened to the supporting surface. This naturally suggests that as each successive female came along with her contribution it was simply attached to one end of the already established cluster. Because of these considerations it would seem that while the male surely spawns with a succession of females, the latter may spawn their entire contents at one time. The grouping of the egg masses is indicated in Text-figure 1. The arrangement in another cluster may be seen in Plate IV, Figure 7. Sometimes the egg masses would be in massive groups as in this figure, but more commonly in linear series. Occasionally one could be found in the form of a flat, circular disc as shown in Plate IV, Figure 8.

The nests, many of which contained well advanced eggs, were first found on February 8. In all, twelve were carefully examined and many others handled that were in a fragmentary or partly destroyed state due to accidents in collecting.

ONTOGENY.

The eggs and their development. The youngest eggs obtained showed the blastoderm in a many-celled stage as a cap on the yolk (Text-figure 2a). They ranged in size from 1.15 to 1.30 mm. in diameter with a mode at 1.20. As already noted, they are attached to each other by a cord of twisted strands which may be seen best in Plate II. Figure 4. This cord possesses a central stalk from which branch off smaller stalks to which the eggs are attached. In a general way these eggs seem to be attached to each other more like those of the Exocoetidae than of any others with which the writer



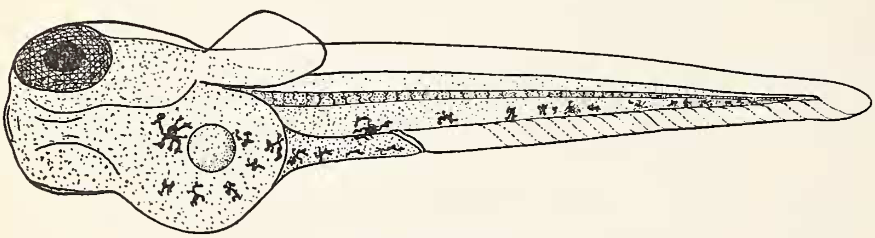
Text-figure 2.

Development of the eggs of *Paraclinus marmoratus*. **A.** Blastodisc in an advanced stage with many cells. **B.** Egg prior to the closing of the blastophore and before evident anterio-posterior differentiation. **C.** Embryo with cephalization well advanced. **D.** Chromatophores developing, the yellow ones indicated by stippling. **E.** Embryo well advanced, with circulation established. **F.** Egg shortly before hatching. See text for full explanation. Camera-lucida sketches from living material.

is personally familiar, see Breder (1938). In finger bowls at a temperature close to 70° F. they advanced to a condition shown in Text-figure 2b in which the developing cells partly invested the yolk, but in which the blastopore was not nearly closed, in a period of 13 hours. The yolk was a very pale amber and the oil droplets a deeper tint of the same color. The mass of cells presented a whitish appearance by reflected light. In 11 hours further the stage shown in Text-figure 2c had been reached. Cephalization had already reached an advanced condition. The condition shown in Text-figure 2d was reached in a further 45½ hours. The yolk was covered with a number of dark, nearly black, chromatophores and yellowish ones were placed at fairly regular intervals along the sides of the body and around the iris. The embryo at this time showed a considerable amount of movement and the beating of the embryonic heart was regular at about 33 beats per minute. By the time another 40½ hours had passed, the egg appeared as in Text-figure 2e. The eye was rapidly darkening and the dendritic chromatophores had somewhat rearranged themselves. Motion of the embryo was greater and the heartbeats had increased to about 37 per minute. In 20½ hours more the eyes had become fully pigmented and presented a bronzy appearance.. Vascularization was prominent and heartbeats had increased to about 150 per minute. This stage is shown in Text-figure 2f. Both blackish and yellowish chromatophores were present on body and yolk. At this time camera lucida drawing became exceedingly difficult on the living egg, not only because of the increasing activity of the embryo, but chiefly because of the increasing opacity of the egg membrane. All during incubation it had been slowly accumulating fine detritus. It would thus seem that the surface of the eggs continues to maintain an adhesive condition that does not disappear with the passage of considerable time. Two days later drawing of the living egg became impossible but the heartbeats remained the same, while the following day the latter became impossible to count. The following day hatching occurred. In all, a period of ten days passed for the hatching of this very slowly developing egg — February 10 to February 20.

Due apparently to the very close matting that these eggs show by virtue of their tangled adhesive threads, they were not easy to incubate in the standing water of a finger bowl. Only when a few were teased well apart could they be incubated at all. In clumps as found they died in a few days, the central ones first, with little doubt, from suffocation. Although these eggs are normally incubated in either absolute or semi-darkness, light as present on the laboratory table seemed to have no influence on them. They were incubated both in darkness and in light with equal success.

The larvae. On hatching, the larvae rested at the surface of the water in an inverted diagonal position. This was caused by the retention of a single relatively large oil globule. A specimen is shown in Text-figure 3 floating in this position as viewed directly from above. It measured 4.1 mm. in over-all length. Due to the necessity of leaving the laboratory at this



Text-figure 3.

Newly hatched larval fish shown from above in the typical floating position. Camera-lucida sketch from living material.

time, it was impossible to continue studies further. Hatched in a comparatively advanced stage and being notably buoyant, these fish should find themselves in the plankton soon after hatching. The coloration of the larval fish was essentially as described for the last stage of the egg figured. The melanophores were seen in an expanded stage and the xanthophores were contracted.

Specimens collected later, in April, by M. B. Bishop, of about 25 mm. in length, were clearly recognizable, appearing very like the larger females. Material at this time and all through the summer was absent from the sponge beds. There is a considerable faunal change in this bay with the seasons and whether these fish change their locale or mostly die after spawning is not entirely clear at this writing.

During July and August of 1938, Mr. Bishop reported finding both adults and young lurking about the marine growths on the piling at Palmetto Key, and during April and May, 1939, he found them in beds of eel grass. Apparently they are not present on the sponge beds of Pelican Bay in the warmer months, but move about in some kind of seasonal migration very likely associated with the temperature differentials in these shallow waters.

Discussion.

Although there are hardly enough data on blenny reproduction to warrant an attempt to compare the various modes employed by these fishes, certain features are evident that are worthy of comment at this time.. The entire group comprising the Blenniodei is marked by a tendency to produce fairly large, heavy and attached eggs which may be attended by one or both parents. This is perhaps related to their mode of life, so closely associated with a sea floor well populated with marauding invertebrates of a large variety.

The related form, *Clinus argentatus* Cuvier & Valenciennes, lays adhesive eggs that are guarded by the male, according to Guitel (1892). This is also true of a wide variety of more or less related forms, as follows: *Blennius pholis* Linnaeus, *B. ocellaris* Linnaeus, *B. gattorugine* Bleeker, Lebour (1927) and Brown (1929); *Blennius sphynx* Cuvier & Valenciennes, Guitel (1893 a and b); *Chasmodes bosquianus* (Lacépède), Hildebrand & Schroeder (1928) and Hildebrand & Cabel (1938) *Hypsoblennius hentz,* (LeSueur) and *Hypleurochilus geminatus* (Wood), Hildebrand & Cable (1938).

In *Pholis gunnellus* (Linnaeus), on the other hand, according to Ehrenbaum (1904) and Gudger (1927), both parents guard the nest, but according to the first without much enthusiasm. The eggs are merely adhesive and in all of the above species no fanning of the eggs has been described. *Paraclinus,* however, is reproducing in water much warmer than that of *Pholis* but, on the other hand, not quite as warm as that of the others, none of which have eggs bound together with threads.

Schultz & DeLacy (1932) describe adhesive eggs for *Anoplarchus purpurescens* Gill, but found that the female did the nest guarding.

Certain other blennies have been described as having threads on their eggs and to this extent resemble our material much more closely. *Blennius montagui* Fleming, Guitel (1893 a and b), and *Heterostichus rostratus* Girard, Barnhart (1932). As in *Paraclinus* the male guards in *Blennius montagui.*

Other species found with eggs, sex not stated, include *Xerepes fucorum* (Jordan & Gilbert), Metz (1912), *Cebidichthys violaceus* (Girard), Schultz & Delacy (1932). The sexual difference of *Clinus superciliosus* (Linnaeus) is described by Gilchrist & Thompson (1911). The eggs and sexual differences of *Blennius pavo* Risso are described by Eggert (1932) and those of

Salarias flavo-umbrinus Ruppell by Eggert (1929). It would be pointless to go on to the other more distantly related blennoid fishes and it may suffice at this time to mention in passing that the above general pattern, with variations, apparently runs pretty generally throughout the entire group.

The period of incubation, while long, is in good agreement with that of other species in which data are available:

	Days	*Temperature °C.*
Paraclinus marmoratus	10	21.5
Hypsoblennius hentz	10—12	24.5—27.0
Hypleurochilus geminatus	6 — 8	26.0—28.0
Chasmodes bosquianus	11	24.0—27.0
Pholis gunnellus	42—70	About 6.

The size of the eggs is also comparable to other American blennies as is indicated below:

	Dia. in mm.
Paraclinus marmoratus	1.15—1.30
Hypsoblennius hentz	0.72—0.80
Hypleurochilus geminatus	0.60—0.75
Chasmodes bosquianus	0.93—1.10[1]
Pholis gunnellus	1.90—2.20
Anoplarchus purpurescens	1.37—1.49
Blennius pholis	1.4

While we need not go into the details of the secondary sex characters in these fishes, there seems to be a general tendency for them to display differences analogous to those described herewith for *Paraclinus*.

Summary.

1. *Paraclinus marmoratus* deposits masses of adhesive eggs, usually in association with the sponge *Verongia fistularis*, sometimes within the lumen of the sponge, in which case they have the aerating advantage of the strong current which these sponges induce.

2. The males guard and fan the egg masses, which may be in several stages of development and on the basis of size of the individual clusters must be the product of several females which would seem to deposit their entire complement at one time.

3. The eggs, which are bound together by a tangled skein of threads, are of unusually slow development, taking at least ten days to hatch under the temperature of their environment, about 70° F.

4. The larvae are pelagic but by the time they are 25 mm. in length have taken up the residence on the bottom and already closely resemble their parents.

5. Sexual dimorphism is marked prominently in the form of the dorsal and head, and individual color and pattern variation is large and changes readily with background and emotional state.

Bibliography.

Barnhart, P. S.

1932. Notes on the habits, eggs and young of some fishes of southern California. *Bull. Scripps Instit. Oceanography* **3** (4) 87-99.

Breder, C. M., Jr.

1938. A contribution to the life histories of Atlantic Ocean flyingfishes. *Bull. Bingham Oceanographic Coll.* **4** (5): 1-126.

1939. On the trail of the tarpon. *Bull. N. Y. Zool. Soc.* **42** (4): 98-110.

[1] Eggs elliptical—long axis measured.

BROWN, E. M.

1929. Notes on the breeding-habits and early larvae of the tompot blenny. *Proc. Zool. Soc. London* 1929: 487-489.

EGGERT, B.

1929. Entwicklung und Bau der Eier von *Salarias flavo-umbrinus* Rupp. *Zool. Anz.* **83**: 241-252.

1931. Die Geschlechtsorgone des Gobiiformes und Blenniiformes. *Zeitschr. Wiss. Zool.* **139** (213): 249-558.

1932. Zur Kenntnis der Biologie der Sekundaren Geschlecht merkmale und des Eies von *Blennius pavo* Risso. *Zeitschr. fur Morph. und Okol. Tiere.* **24** (3-4): 682-703.

EHRENBAUM, E.

1904. Eir und Larven von Fischen der deutschen Bucht. III Fische mit festsitsenden Eiren. Wiss. Merresuntersuch. Keil, (Abt. Helgoland) n.s. **6**: 127-200.

GUDGER, E. W.

1927. The nest and nesting habits of the butterfish or gunnel, *Pholis gunnellus. Nat. Hist.* **47** (1): 65-71.

GILCHRIST, J. D. F. & THOMPSON, W. W.

1911. The Cape Klip fishes of South Africa. *S. A. Journ. Sci.*, Cape Town. **7**: 214-224.

GUITEL, F.

1892. Sur les moeurs du *Clinus argentatus* Cuv. et. Val. *Comp. Rend. Acad. Sci. Paris.* **115**: 295-298—*Bull. Soc. Centr. Aquicult. France.* **4**: 165-167.

1893a. Observations sur les moeurs do trois blenniides, *Clinus argentatus*, *Blennius montagui* et *Blennius sphynx. Arch. Zool. Exper. Gen.* 3 ser. **1**: 325-384.

1893b. Sur les moeurs du *Blennius sphynx* Cuv. et Val. et du *Blennius montagui* Fleming. *Comp. Rend. Acad. Sci. Paris* **117**: 289-291—*Bull. Soc. Centr. Aquicult. France.* **5**: 13-16.

HILDEBRAND, S. F. & CABLE, L. E.

1938. Further notes on the development and life history of teleosts at Beaufort, N. C. *Bull. U. S. Bur. Fish.* **48** (24): 505-642.

HILDEBRAND, S. F. & SCHROEDER, W. C.

1928. Fishes of Chesapeake Bay. *Bull. U. S. Bur. Fish.* (1927) **43** (1): 1-366.

LEBOUR, M. V.

1927. The egg and newly hatched young of the common blennies from the Plymouth neighborhood. *Jour. Mar. Biol. Assoc.* **14**: 647-650.

METZ, C. W.

1912. The fishes of Laguna Beach, California. *Rept. Laguna Mar. Lab.*, Claremont. **1**: 57, 63.

SCHULTZ, L. P. & DELACY, A. C.

1932. The eggs and nesting habits of the crested blenny, *Anoplarchus. Copeia* (3): 143-147.

STORY, M.
(in press)

1940. Suppression of two generic names (*Auchenopterus* and *Cremnobates*) of tropical American blennioid fishes, with notes of systematic characters. *Copeia.*

EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. Adult male and female *Paraclinus marmoratus* in an aquarium. The nearest fish is the female. The dorsal differentiation is evident.

Fig. 2. A male guarding its eggs after being removed to an aquarium. The full erection of the first dorsal accompanies alarm, in which case it is thrust anterior to a vertical. These eggs form a massive cluster in the central portion of the broken sponge and the fish sits on the bottom at the left of the sponge.

Plate II.

Fig. 3. A male guarding a small cluster (a single spawning) on a sea fan in a tank of the New York Aquarium.

Fig. 4. Photomicrograph of developing eggs. The egg in the upper right corner is more advanced than the rest. The cloudy mass in the center and left is one of the tangled skeins of threads that bind the eggs together.

Plate III.

Fig. 5. Eggs of *Paraclinus* in the vertical lumen of a sponge. This is the same example that is indicated diagrammatically in Text-figure 1.

Fig. 6. Eggs of *Paraclinus* in a horizontal connecting lumen of a sponge. The vertical portions may be seen in the background.

Plate IV.

Fig. 7. A massive cluster of eggs on the exterior of the base of a sponge. Several groups of eyed eggs may be distinguished among others not so advanced. This was an especially large cluster.

Fig. 8. A flat circular mass of eggs on the basal portion of a sponge. Such clusters were not common, the massive type being the most general.